Effects of conservation tillage on nutrient losses to runoff in alternative and conventional farming systems

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Project Leaders
Leisa M. Huyck
Sustainable Agriculture Farming Systems Project
Department of Agronomy & Range Science
University of California
Davis, CA

Jeff Mitchell
Department of Vegetable Crops
University of California, Davis
Kearney Agricultural Center
Parlier, CA

William Horwath & Wes Wallender
Dept. of Land, Air, & Water Resources
University of California
Davis, CA

Cooperators
Jim Jackson
Dept. of Vegetable Crops
University of California
Davis, CA

Bruce Rominger
Grower
Winters, CA

Tony Turkovich
Grower
Winters, CA

Scott Park
Grower
Meridian, CA

Introduction

Agricultural runoff is a major pathway for loss of nutrients from farm soils. Nutrient losses to runoff result in inefficient use of fertilizer and mean both higher costs to farmers, as they pay to replace the lost nutrients, and higher costs to society as it pays to clean up degraded waterways

Conservation tillage (CT), with necessitated changes in irrigation system design and efficiency, and cover-cropping, are two avenues for reducing runoff and decreasing nutrient losses. These management alternatives also have the potential to improve many other aspects of farm management for California growers, including reducing labor and fuel costs, increasing soil water storage, decreasing water usage, decreasing dust emissions, increasing carbon sequestration, and increasing net revenues. No studies have been done in California to evaluate the separate and/or combined effects of CT and cover-cropping, on runoff and consequent nutrient loss to surface waterways, in conventional or alternative production systems.

The purpose of this project is to quantify relationships between tillage and fertility management, and runoff and nutrient loss from soils farmed using organic, low-input, and conventional practices. Measurements will be made of runoff from plots at the Sustainable Agriculture Farming Systems (SAFS) research site at UC Davis, a long-term comparison of organic, low-input, and conventional farming systems, and from farm fields provided by SAFS grower-collaborators. Grab samples will be taken from the runoff and analyzed for suspended sediment and nitrogen and phosphorus content. The well-developed SAFS outreach structure will be used to extend the results of the study to farmers, farm advisors, policymakers, and the general public.

Objectives

1. To quantify the amount of runoff from plots and fields farmed using organic, low-input, and conventional practices, with conservation and standard tillage.
2. To quantify the amount of nitrogen, phosphorus, and sediment in this runoff.
3. To extend the results of this study to farmers, policymakers, and the general public.

Description

This project is a three-year effort to quantify relationships between tillage, fertility management, runoff, and nutrient loss to surface waterways, from soils farmed using several different resource management strategies. Measurements necessary to quantify these relationships will be made in fields provided by three growers in Yolo County, and at the Sustainable Agriculture Farming Systems (SAFS) research site on the UC Davis campus. This experiment will take advantage of an established long-term research site with a history of organic, low-input, and conventional management. Organic fertility management combines manures and cover-cropping, low-input integrates cover-cropping and commercial fertilizer, and conventional management relies on commercial

fertilizer alone. The plots are being converted to a study of conservation vs. standard tillage in all three management systems. The experiment will also take advantage of growers' interest in examining relationships between tillage, cover-cropping, and nutrient runoff.

At the SAFS site, plots of one-third acre each (to allow use of full-scale farm equipment) will be treated with a tillage x farming system factorial design for conventional, organic, and low-input systems. All farming systems will have had at least a 12 – year history of management under their defining criteria. All farming-system treatments will use "best farmer management practices," to be determined by consensus of the research team, which includes farmers and farm advisors. The SAFS project is unique in that farmers participate in every stage of the research process, including planning and design, execution, and interpretation and dissemination of results.

The conventional systems will be managed with practices typical of the surrounding area, which include the use of synthetic fertilizers and pesticides. In the low-input systems, fertilizer and pesticide inputs will be reduced primarily by using legume cover crops to improve soil fertility, and predominantly mechanical cultivation for weed management. The organic system will be managed according to the regulations of California Certified Organic Farmers (CCOF, 1995), with no use of synthetic chemical pesticides or fertilizers. Instead, management will include the use of cover crops, composted animal manure, mechanical cultivation, and limited use of CCOF-approved products. Tillage and farming operations will be conducted for the first two years as shown in Table 1.

At growers' fields, the size of plots or fields to be dedicated to the study will be decided by the growers. The basic rotation will be a 2-year one of tomatoes and corn, starting with tomatoes. Two treatments will be used: the normal growers' practices for the site, and a conservation tillage treatment to be decided upon by consensus of growers and researchers.

<u>Measurements:</u>

Runoff

Runoff from each plot will be channeled through a v-shaped weir draining into a ditch at the end of each plot. Because the opening of the weir is a known dimension, the rate of runoff is proportional to the height of water flowing through the weir. The water height will be measured with a pressure transducer placed at the bottom of the weir and connected to a datalogger. This system allows readings to be taken several times a minute so that the rate of runoff can be plotted over time and directly related to rainfall intensity.

Nitrogen and phosphorus

Grab samples of 500 mL of runoff water will be taken at regular intervals during any storms of high enough intensity to generate runoff. Samples will be analyzed for total suspended solids, nitrate, ammonium, total N, and total P in the solids, and ammonium, nitrate/nitrite, TKN, and TP in dissolved form.

Results

There are no results as yet. Due to delays in funding the project was not commenced until October 2002.

Table 1. Production practices for all treatments.

Conventional		Cover Cropped		Organic	
CT	ST	CT	ST	CT	ST
Corn					
DEC-Apply fallow herbicide March-plant corn with starter fertilizer and banded herbicide) April- cultivate 2x and side dress fertilizer April-July-irrigate 6x Sept- Harvest	Aug-Disc 2x Aug-triplane 2x Oct-list 60" beds Dec-apply fallow herbicide Mar-plant corn with starter fertilizer and banded herbicide Apr-cultivate 2x and side dress fertilizer Apr-July-irrigate 6x Sept-Harvest	Oct-plant Faba cover crop Mar-Apply cover crop burn down herbicide Mar-chop cover crop Mar-plant corn with starter fertilizer and banded herbicide Apr-cultivate 2x and side dress fertilizer Apr-July-irrigate 6x Sept-Harvest	Aug--disc 2x Oct--plant cover faba cover crop Mar--chop cover crop Mar--disc cover crop 2x Mar-stubble disc 1x Apr-Triplane Apr-List 60" beds Apr-preirrigate Apr-dry mulch beds Apr-plant corn with starter fertilizer and banded herbicide May-cultivate 2x and side dress fertilizer May-Aug -irrigate 6x –Oct- Harvest	Oct--plant Faba cover crop Mar--chop cover crop Mar--plant corn with organic starter fertilizer Apr--spread Manure Apr--cultivate 2x Apr-July--irrigate 6x Sept--Harvest	Aug--disc 2x Oct--plant faba cover crop Mar--chop cover crop (March) Mar--disc cover crop 2x Mar--spread manure Mar--stubble disc 1x Apr--Triplane Apr--List 60" beds Apr--preirrigate Apr--dry mulch beds Apr--plant corn May--cultivate 2x May--irrigate 6x Oct--Harvest
Tomatoes					
Sept--chop residue Dec--apply fallow herbicide Apr--strip till bed centers Apr--incorporate preplant herbicide Apr--transplant tomatoes May/June--cultivate 3x May--sidedress fertilizer Apr/June--irrigate 6-7x Aug--harvest	Sept--chop residue Sept--disc 2x Sept--deep rip Sept--disc Sept--triplane 2x Oct--list beds Dec--apply fallow herbicide Apr--work beds Apr--incorporate preplant herbicide Apr--transplant Apr/May--cultivate 3x May--sidedress fertilizer Apr/July--irrigate 6-7x Aug--harvest	Sept--chop residue Nov--drill faba bean cover crop Mar--apply burn down herbicide to cover crop Mar--Chop cover crop Apr--strip till bed centers Apr--incorporate preplant herbicide Apr--transplant Tomatoes Apr/May--cultivate 3x May--sidedress fertilizer Apr/July--irrigate 6-7x -harvest (Aug)	Oct--chop residue Oct--disc 2x Oct--deep rip 2x Oct--disc Oct--plant faba bean cover crop Apr--chop cover crop Apr--disc 2x Apr--stubble disc Apr--disc Apr--triplane 2x Apr--list 60"beds Apr--incorporate preplant herbicide Apr-Transplant May--sidedress fertilizer Apr/May--cultivate 3x Apr/July--irrigate 6-7x -harvest (Aug)	Sept--chop residue Nov--drill faba bean cover crop Mar--chop cover crop Apr--strip till bed centers Apr--transplant Tomatoes with organic starter fertilizer May-sidedress manure Apr/May--cultivate 3x Apr/May--irrigate 6-7x Aug--harvest	Oct--chop residue Oct--disc 2x Oct--deep rip Oct--disc Oct--Triplane 2x Nov--plant faba bean cover crop Mar--chop cover crop Mar--disc 2x Apr--stubble disc Apr--disc Apr--triplane 2x Apr--spread manure Apr--list 60"beds Apr--transplant Apr/May--cultivate 3x Apr/May--irrigate 6-7x Aug--harvest